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955 L'Enfant Plaza North, S.W.
Washington, D. C. 20024

date: November 2, 1971

to: Distribution

from: A. J. Michael

B71 11004

subject: Review of Apollo 15 Weight Growth
History for Estimating Expected
Growth on Apollo 16 -- Case 310

ABSTRACT

Apollo 15 weight growth history was reviewed to provide a background for estimating expected growth on Apollo 16. This history shows that there should be an expected LM weight growth of approximately 17 pounds on Apollo 16 exclusive of the changes resulting from the anomalies experienced on Apollo 15.

Because of the excellent resolution photography of lunar geologic features obtained on lunar traverses of the Apollo 15 mission using the 500 mm lens camera, it is highly desirable to provide this camera system on the Apollo 16 mission. It has been concluded that even with the expected weight growth of Apollo 16 to the time of launch, there is sufficient performance margin to recommend the addition of the 70 mm camera and 500 mm lens system. It is further recommended that the total LM control weight remain at its current value of 36,300 pounds but the landed payload control weight be changed to a value of 1230 pounds from its current 1200 pound value.

(NASA-CR-125368) REVIEW OF APOLLO 15 WEIGHT
GROWTH HISTORY FOR ESTIMATING EXPECTED
GROWTH ON APOLLO 16 (Bellcomm, Inc.) 6 p

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MEMORANDUM FOR FILE

The weight changes occurring on Apollo 15 during the six months prior to launch were reviewed. Approximately 70% of these weight changes made were also incorporated on the vehicles of the remaining two missions. Only those changes peculiar to Apollo 15 were not carried over to Apollo 16 and 17.

The weight growth for Apollo 15 during the six months prior to launch was 69, 37, 29 and 28 pounds for the CM, SM and LM ascent and descent stages, respectively. If we assume that 70% of the basic changes have already been incorporated in Apollo 16, there should be an expected growth of approximately 21, 11, 9 and 8 pounds in the CM, SM and LM ascent and descent stages, respectively, during the interim before launch based on Apollo 15 history. This does not take into consideration any specific changes resulting directly from the Apollo 15 mission.

The 70 mm camera with the 500 mm lens proved to be very successful on Apollo 15, producing excellent resolution photography of detail geologic structure in distant features. Similar geologic opportunities will be available on Apollo 16, such as the far wall of North Ray Crater. This camera system will undoubtedly be considered as a high priority item for the Apollo 16 mission.

Preliminary results from the use of the Rover on the lunar surface for the first time during the Apollo 15 mission show that some changes will be desirable prior to the flight of Apollo 16. Several items are currently under investigation; however, no assessment is available for the weight penalty resulting from the potential changes. Some of the items under consideration are:



- a) Seat belt modification,
- b) TV cable rearrangement,
- c) Battery overheating problems,
- d) TV control problems,
- e) Steering problems.

Lunar surface experiments and equipment which had anomalies during the Apollo 15 mission are being investigated and could also result in changes affecting LM weight. Some of these items are:

- a) The lunar drill,
- b) The heat flow experiment probes,
- c) Camera magazines jamming.

A performance status plot of LM-11 (Apollo 16) was generated and is shown in Figure 1. This plot shows the LM control and limit weights along with the current weight status (10-15-71) of LM-11. Two total LM limit weights are shown, one is the current status (10-15-71) as presented by MSC and the other shows the adjustment resulting from the use of lower 3σ dispersions based on actual engine I_{sp} dispersion data of LM-10 (Apollo 15). It is anticipated that LM-11 will have a similar I_{sp} dispersion. It can be seen from this plot that the total LM weight could increase by 72 pounds without exceeding the control weight. Based on the adjusted LM limit weight, which is the anticipated system performance capability, the total LM weight could increase by 190 pounds from the current status (10-15-71). The 190 pounds is equivalent to about 11 seconds of hover time which is close to the margin above budget available for Apollo 15. If the remaining weight growth for LM-11 is similar to that of LM-10, i.e., about 17 lbs., there still would be 173 pounds of weight margin based on the adjusted LM limit weight. Although the LRV and surface equipment fixes will impact the lunar landed payload by some amount, it appears that there is sufficient margin to approve the addition of the 70 mm camera with the 500 mm lens system for Apollo 16. The weight of the camera system and its stowage is approximately 15 pounds.

The control weight for the lunar landed payload is 1200 pounds; however, the current (10-15-71) payload status is 1212 pounds. Most of the changes discussed in this memo would



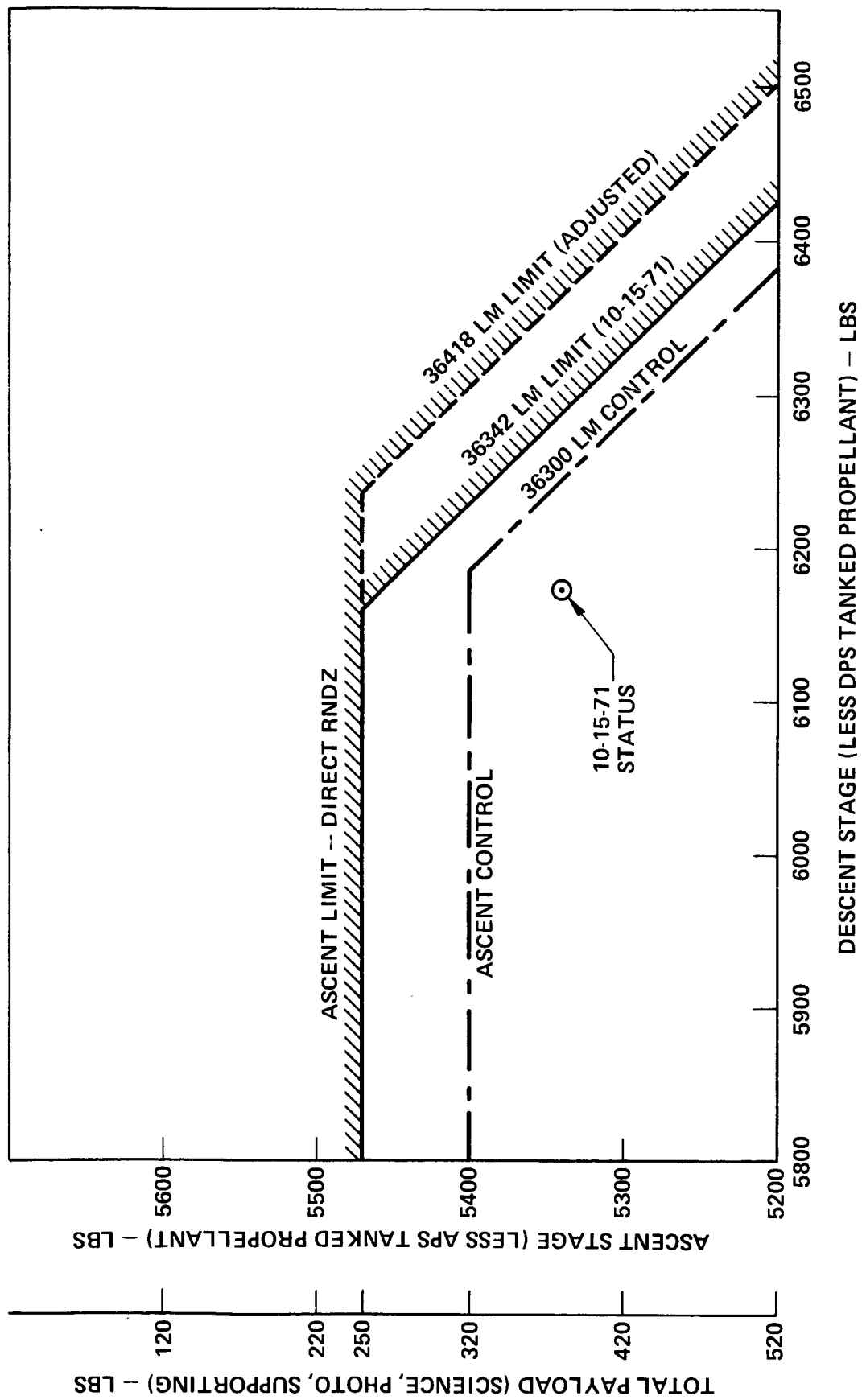
increase the landed payload weight causing the control weight to be exceeded still further. In the past the control weights were changed by Level I CCB waiver action prior to flight. Apollo 15 was launched with a landed payload weight of 1221 pounds and CCBD APO 248 dated July 9, 1971 allowed a landed payload weight as great as 1230 pounds. The control weight for landed payload on Apollo 16 should reflect the approved payload to actually be carried. With the approval of the 70 mm camera and 500 mm lens we would recommend that the landed payload control weight be changed to reflect the approved payload (1227 pounds with the addition of the camera) with some small margin for growth. A new control weight of 1230 pounds would seem to be a reasonable figure. This increase in the landed payload control weight would not change the total LM control weight of 36,300 pounds.

2013-AJM-jab

Attachment

A. J. Michael
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FIGURE 1
PERFORMANCE STATUS
LM-11





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